

LABORATORIES THAT TURN LOSSES TO PROFITS

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by
Forrest Crissey



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LABORATORIES THAT TURN LOSSES TO PROFITS

AMONG American business men the notion has long persisted that, though chemists and laboratories are all right for the great industrial giants, they are doubtful luxuries for smaller concerns. This conviction that the benefits of expert chemical advice are logically beyond the reach of the small and struggling factory has been a costly error for the industries of this country as a whole. Many a promising manufacturing enterprise has either led a starved and stunted existence or has gone down in defeat for lack of the assistance to be had from a good industrial chemist.

The prevailing opinion that the little fellow in the manufacturing field cannot afford to secure this kind of scientific help is fast changing to the contrary conviction that it is likely to prove about the cheapest and most profitable service he can buy. Almost every day sees a larger percentage of comparatively small manufacturing concerns spending good money for laboratory assistance. Often, if not generally, the pressure of some acute emergency is required to bring the courage of the small manufacturer up to the point where he is willing to invest in a little laboratory research.

Here is a case typical of hundreds of others illustrating the common course by which industrial chemistry gets its recruits from the ranks of the small manufacturers in this country:

Two young Italians, who had worked in a small but successful macaroni factory in the East, started an enterprise of this kind in a Western city. Their drier was an exact reproduction of the one in

the plant where they had worked. The product of their little factory was entirely acceptable to their market; and, as both these young Neapolitans were hustlers and were well located, their business grew in the course of a few years to a point where they faced the necessity of providing a much larger output.

Consequently they built an addition to their factory and installed a drier of large capacity, calculated to take care of all the expansion they could reasonably expect in the next few years. The new drier was modeled after the one that had given them such satisfactory service from the very beginning of their business.

Probably one of the greatest strains to which the true Neapolitan temperament was ever subjected was exerted when the two partners made the discovery that the product of their new drier was so far inferior to that of the old one as to spell failure for them unless the trouble could be corrected. Instead of being hard and brittle, and breaking with a long fracture,

the tubes of macaroni from the new drier were green and semi-elastic, with the result that they were both unacceptable for immediate use and were prone to mold and spoil.

An Italian Climate to Order

ONE alteration after another was made in the equipment of the new drier, but without producing any marked improvement in the product. This period of hit-or-miss experiment extended over several months, the proprietors growing more desperate with every passing week.

Finally they took one of their most intelligent customers into their confidence and he advised them to consult a leading chemical engineer, whose laboratories were located in Chicago. He warned them that probably the fee would not be small and that satisfactory results could not be guaranteed. As it was clear to them that they were facing financial ruin, they decided to accept the alternative, take the chances, and see what lab-

oratory science could do for a macaroni drier and its product.

The chemical engineer first satisfied himself that the failure of the product was not due to any defect in the materials used—which were found to be of the highest quality—but that the fault must lie in the curing alone. He then defined his problem by saying that it was up to him to create, inside of that drier, an ideal Italian climate which could be relied upon to remain the same day after day. This he finally succeeded in doing, securing a combination of heat, humidity and air velocity that was practically “foolproof,” and that cured the macaroni as perfectly as if it was dried in the sunshine and breezes of Italy.

Naturally, any attempt to convince these two Neapolitans that industrial chemistry is either impractical or too expensive an aid for the small manufacturer would be so much wasted breath. They look upon the laboratory of the consulting chemist to whom they ap-

pealed for help very much as a rescued seaman might look upon the life-saving station whose crew had saved him when he seemed ready to sink.

The failure of a manufacturing process is not the only whip that drives the small manufacturer to what he is inclined to consider the doubtful expedient of employing a chemist to solve his most pressing problems of production. The lash of strong competition is often an equally powerful stimulant of interest, on the part of the small and struggling manufacturer, in the possibilities of the chemist as a thrower of business life lines.

One morning, in the spring preceding the outbreak of the European war, a certain young man, not long out of college, made the interesting discovery that an ice-cream business had been wished on him by way of a mortgage foreclosure. It was in dire need of first aid in the form of a bit of energetic business management. He decided to step into the breach

himself and see what he could do by way of pulling the business out of the hole.

In a few weeks he discovered that the most careful management was required to turn out a high-grade product and sell and distribute it at a profit. In spite of the high cost of cream, he managed to make a reasonable profit until the pastures began to give out in the fall and cream made a corresponding advance.

A little exercise with a lead pencil showed the young adventurer in the ice-cream business that the winter trade must be supplied at a loss, and that he had the choice of three courses: He must borrow the money to finance the winter's loss on the basis that he could get it back again when the price of cream again dropped to the summer level; or he must sell out to a competitor on decidedly disadvantageous terms; or he must discover some new way by which he could manufacture winter ice cream at a cost not materially greater than that which his

product had stood him through the summer.

Each of these roads seemed to be blocked by an almost insurmountable obstacle. It would be hard for him to induce a bank to lend him enough money to carry his business over a losing season; his banker had already made that quite clear. The obstacles in the way of the second course, that of selling out and retreating from the field, were the facts that he was not an easy quitter and that his pride prodded him on to make a success of this enterprise in which a relative had scored a failure. As to the third expedient, that of discovering some means of bringing the manufacturing cost of winter ice cream down to the summer level, that path seemed to end in a rainbow lettered large with the word Impossible!

He was morally certain that his competitors, operating on a much larger scale, would be well satisfied if their winter's business paid its own way. How-

ever, they were in a much stronger position financially and could tide the business over the winter without feeling any particular strain. Though he knew that the way of discretion was to sell out and acknowledge his defeat with such grace as he could command, it was impossible for him to bring himself to choose a course so humiliating.

Being young, a college man, and a firm believer in modern forces and methods, he determined to see whether science could not show him a way out. Therefore he went to a prominent consulting chemist and put his troubles on the table. To his surprise, the chemist remarked that unless he was greatly mistaken he had cracked many a harder nut.

The laboratory man worked by process of elimination and soon reduced the problem to this plan:

The price of powdered milk remained the same in winter as in summer; in other words, it rests upon the cost of pro-

duction in the cheapest season of the year. Sweet or unsalted butter, held in cold storage, can usually be bought in winter at a price quite low when compared with the winter price of fresh cream.

Problems in Ice Cream and Bone Dust

“**I**T LOOKS to me,” announced the laboratory man, “as if the job before us is simply that of finding a way of mixing powdered milk, distilled water and sweet butter together into a first-class article of cream. If this can be done by a process that is not in itself expensive you ought to be able to make winter ice cream as cheap as your summer product made from fresh cream, or perhaps a little cheaper.”

The riddle was solved by the development of a simple machine that combined these elements under high speed, making them into a permanent emulsion that when frozen a connoisseur could not tell from the finest ice cream made from nat-

ural cream. There was nothing cheap about the product except its cost of manufacture. The powdered milk furnished the solids, while the sweet butter brought the fat content up to any desired standard. In order to give his product an extra selling point this young manufacturer saw that it was made just a little richer than the ice cream marketed by his competitors.

As a result of his adventure into the field of industrial chemistry, this young manufacturer turned the winter of his discontent into a season of larger profits than he had secured in the summer, and made almost sensational strides in the way of getting new business. For some time his competitors were at a loss to understand how he was able to undersell them in the winter; but when his biggest competitor sent samples of the young man's winter cream to a consulting chemist the secret was soon out.

To take a common nuisance—a clear legal liability—and turn it into a steady

cash income is certainly an achievement that is bound to command the respect of the most sordid and practical mind. Industrial chemistry has done this not once but scores and hundreds of times. It might almost be said that this is the favorite parlor trick of the modern chemical engineer.

An example of this peculiar form of laboratory service is furnished by the experience of a manufacturer of bone buttons. The town in which he located his enterprise was eager to secure the factory. After the plant was built and had been in operation a short time, the ardor of the inhabitants cooled and the authorities began to threaten the button manufacturer with damage suits and with prosecution for maintaining a common nuisance.

The cause of this reversal of public sentiment was apparent to the eye of the most casual visitor in the town. The entire landscape within a radius of several blocks from the factory was covered with

a coating of fine white dust. This, of course, came from the factory blowers, into which the dust from the polishing rooms was collected by suction. As a consequence of steadily discharging this volume of minute dust particles into the air the town took on a ghastly gray color, and the trees and shrubs began to die.

When the coating of bone dust thickened upon the entire town the situation of the manufacturer became more acute. He reminded the real-estate men that he had urged them to give him a location on the opposite side of the town, where the prevailing winds would have carried the dust off into the country, instead of drifting it upon the town.

The members of the committee with whom he had dealt retorted that if he had explained why he wished to locate on the other side of town they would have broken off the negotiations and refused to have the factory at all.

Every day of delay increased the depth of the pestiferous dust coat on the local

landscape and increased the animosity of business men and housekeepers, who resented the despoiling of their goods and chattels and the peril to public health.

In sheer desperation, however, he wrote to one of the firms from which he had bought certain features of his equipment and was, in turn, advised to employ a chemical engineer. It was suggested that possibly a certain technical school would send a young man who could work out the problem. As his situation was daily becoming more desperate, he made haste to try the first chemist suggested by the school, though the head of that institution took pains to emphasize the fact that the young man in question was without much industrial experience, and that satisfactory results could not be guaranteed.

The Young Chemist's Thrilling Results

AFTER the chemist had been at work for a fortnight the owner of the factory called him into the office and

asked for a report on results. He was both astonished and discouraged on being told that it might take months of patient digging and experimenting before anything practical would result. However, the manufacturer knew that his case was one of extreme necessity and so he told the young man to go ahead with his investigations and push them as rapidly as possible. As a stimulus to haste he named a substantial bonus that would go to the chemist in case he worked out a practical solution of the dust problem.

Fortunately this young man possessed an almost ideal temperamental equipment for his profession, in that he had almost as good a gift for mechanics as for chemistry. This was his first big opportunity and he worked night and day to make good at it. Besides, he needed that bonus in his business. At times it seemed to the button manufacturer that the young scientist was perversely slow

and that his experiments amounted to little more than childish pottering.

But one day, when the owner of the factory returned from a trip to New York, the air in the vicinity of the plant seemed to be a little peculiar. He quickly noted that the wind was blowing from the usual direction; if things were normal he ought to inhale enough bone dust with every breath to send a stranger unaccustomed to the local atmosphere, into a fit of coughing. But there was no dust. The hope raised by this condition was fully verified by what he found on entering the factory.

The device for capturing the fugitive dust particles, which had been installed on the day he had left for New York, had worked almost perfectly. It was plain to the harassed button manufacturer that he had nothing further to fear from the town authorities, as the cause of their complaint was now completely removed.



The Chemist Called the Attention of the Manufacturer to the Fact that This Dust Could be Used as the Chief Element in a Highly Concentrated Plant Food

“You get the bonus; and you’re mighty welcome to it!” he told the chemist as he reached for his check book.

“But,” remarked the young man, “I have told you only part of the results. Here is a written report covering the quantity of dust accumulated each day, and I think you will be surprised to see how much it will total for a month at the

present rate of deposit. This dust is just the thing for the manufacturer of the finest kind of plant food known to the fertilizing industry. Attached to my report you will find an offer for this dust that looks decidedly good to me."

The cash income from this peculiar by-product was not only sufficient to pay all the costs of the investigation and development work, but also to continue the chemist upon other problems—particularly those intended to make the factory a healthier place in which to work.

This has been the experience, on a larger scale, of almost every cement factory in the country. Until a process for capturing the great outpouring stream of minute dust particles from works of this nature was devised, the surrounding landscape was desolated, and the health of all who came into contact with this sinister deposit from the atmosphere was injured or imperiled.

A method of securing large quantities

of potash from this captured dust has been perfected and standardized by the chemists, who have wrestled with this problem and turned a public peril and a legal liability into a substantial source of income.

Few features of industrial laboratory work are more fascinating than its service in improving the sanitary quality of products for household or personal use.

The feather pillow of commerce affords an excellent case in point. A certain pillow manufacturer, with a decidedly progressive streak in his make-up, became disgusted with conditions that seemed to obtain in the very best product, and which had long been accepted by the whole trade as inevitable. This manufacturer, however, could not bring himself to accept these conditions as incurable. He reasoned that, because of the intimate contact of a pillow with the human face for several hours of every day, it ought to be sanitary in the strictest sense of the term. On the other hand, he knew that

this was far from being the case. First-hand observation showed him that a process of disintegration was industriously at work breaking down the structure of feathers in a pillow.

The result of this process was a minutely fine dust, capable of working its way through the fabric of the pillow and its case. Naturally this means that more or less of it must be inhaled by the person using the pillow. The fact that large quantities of pillow feathers are imported from China and from other foreign countries did not tend to make this consideration any more tolerable to the manufacturer, who abhorred the idea of dealing in an article he did not consider as really sanitary.

If he had to breathe the dust of disintegrating feathers, he preferred those from American poultry yards to the Oriental article, grown under conditions of filth and unwholesomeness repellent to the people of this country.

This ambition to produce a strictly sanitary feather pillow led the aggressive young manufacturer to appeal to a consulting chemist of high standing. The laboratory work resulted in an inexpensive chemical treatment of the feathers at the time of their renovation, which practically put a stop to the subtle process of disintegration. In other words, feathers subjected to this treatment became almost dustless. In a commercial way this meant not only a pillow of immensely improved sanitary standard but also a decided extension of the life of the feathers.

Industrial chemistry seldom gives what may be called single results. The fruits of this science seem to come in clusters or in pairs. The solution of the pillow-dust problem was no exception to this rule. The chemist who succeeded in solving the problem of pillow dust called the attention of the manufacturer who employed him to the fact that this dust could be used as the chief element in a

highly concentrated plant food much in demand for greenhouse use—a fertilizer at once odorless and powerful. While this manufacturer is immensely proud of the fact that the pillows he places on the market are practically dustless, his monthly income from the sale of feather dust amounts to a material sum. The explanation of this is that the dust is removed from the supply of feathers bought in the open market and from those in used pillows sent to him for renovation.

Of course the greatest benefit this manufacturer received from his investment in a little laboratory science was the improvement in the standard of his product. It gave him a selling argument that was supported by fact and experience.

In this connection it should be remembered that anything which will infuse this kind of blood into the veins of a selling organization is cheap at almost

any price to a manufacturer operating upon a large scale.

To be able to furnish an article to the trade that is indisputably superior to competing products, and that can be furnished at the same price, is a rare privilege in manufacturing experience. This progressive pillow manufacturer can speak in large figures from the right side of the ledger as to what it means in the matter of increasing the volume of business without sacrificing the fraction of a per cent in profit margin. His business has gone ahead by leaps and bounds ever since he convinced the trade that he is supplying a sanitary, dustless pillow.

The Troubles of a Paint Maker

ONE of the most persistent problems with which the manufacturing industry has to deal is that of making its product stand up under the varying conditions encountered in a wide geographical distribution. This endurance test applies not only to intrinsic merit and

life of service, but to appearance as well. Many times the success of a product turns upon this point of appearance alone. In many instances the industrial chemist, the laboratory expert, is the one who decides this commercial contest and tips the scales on the right side by supplying the missing element that prevents the appearance of the product from breaking down under unfavorable climatic conditions, or other adverse influences that could hardly be taken into consideration at the outset of manufacture.

The experience of a maker of water colors of the sort commonly used in the public schools illustrates this type of emergency most clearly. This manufacturer had no training in chemistry, but he considered that several years of experience in the mixing room of a large color house was the only preparation needed for a successful career in the manufacture of school water colors. He held that he was thoroughly practical, and was perhaps a little inclined to look upon chemists as scientific theorists.

When he sent out his little boxes of water colors the cakes "looked good enough to eat," and had all the finish and brilliance of the best colors with which they came into competition—those put out by much larger concerns, which had long been in this special field.

His selling organization was good and almost immediately his product secured a wide distribution. With the coming of the hot season in the South, however, his troubles began. The retail dealers began to return his boxes of colors, with highly critical comments. Only the most casual glance at the little cakes was necessary to disclose why the storekeepers were sending them back with such unfriendly remarks—the surface of each cake was covered with minute crackles, which in many instances had developed into surface cracks.

So long as the cakes remained intact they were just as usable as when they first left the factory; but their peculiar appearance rendered them quite as unsal-

able as if they had granulated into the fine powder from which they were made. Despite his pride in the practicalness of his training, this manufacturer knew that it was up to him to work a radical change in the ability of his product to stand up under diverse climatic conditions, and to do this with all possible speed. As he put it to the head of the laboratory to which he was sent by his head salesman:

"I'm in search," he declared, "of a beauty doctor for my product. I've got to have something that will ward off wrinkles and preserve the satiny cheek of youth in my cakes of paint. If you can't accomplish it for me I guess I'll have to go out of the business. Beauty may be only skin deep; but I've had a mighty costly lesson on the text that if my product can't keep its good looks it has about as little chance in the market as a woman with a ruined complexion and a million wrinkles has to capture a husband where satin skinned débutantes are as thick as automobiles in Los Angeles."

In a shorter time than he himself had hoped, the chemist was able to offer the manufacturer a clear solution of his problem. He had developed a process of combining the necessary materials under pressure instead of mixing them with water. Laboratory tests demonstrated that these cakes would stand a high degree of heat without showing the slightest tendency to crackle. Sample cakes were submitted to experienced artists, who reported that the colors worked freely and were satisfactory in every way.

The business disaster this manufacturer faced was averted at almost the eleventh hour, and he gives the industrial chemist full credit for his rescue.

A Baking Powder Mystery

THE manufacturer who has not had the product upon which his commercial reputation is based suddenly go back on him, through some mysterious and wholly unaccountable cause, is for-

fortunate. Common experience is decidedly of an opposite character. The selection of raw materials may be carefully covered by specifications, and these supplies may be drawn from the same source, and still they will suddenly seem to have undergone an almost complete transformation in their nature. The consternation caused in a manufacturing business by an occurrence of this kind is only to be appreciated by those who have fought through such an experience. It is guaranteed to give symptoms of heart failure to the most successful and self-confident manufacturer.

The very mystery that surrounds the eccentric behavior of materials in a situation of this sort enhances the fear that is felt by all who are vitally concerned in maintaining the standard of the product. Perhaps this type of experience has served to send more small manufacturers to the laboratories of consulting chemists than has anything else. One reason for this is the fact that the manufacturer

who prides himself upon being practical is inclined to feel that almost the whole problem in buying raw materials is that of finding concerns of the most scrupulous honesty and sticking to them through thick and thin. Raw materials of almost every sort, however, are subject to the most subtle changes, which creep in without publishing their presence.

Believers in "the depravity of inanimate things" will find this field strewn with examples to support their theory. If raw materials were capable of intelligent conspiracy, to the end of breaking down the honorable reputation of the most upright men using and dealing in them, they could scarcely do more effective work in that direction than they have done in thousands of cases that have sent factory owners in consternation to the laboratories of industrial chemists.

One of the most celebrated consulting chemists in the city of New York illus-

trates this line of experience with the following incident:

One day a highly excited man was admitted to his office and opened the conversation with the statement that, unless the laboratory could give him quick and certain aid, his business would be ruined.

Then he explained that he had for years been in the business of making a brand of baking powder, which had built up a splendid reputation among its users on its merits alone. Before starting in this business he had been a workman in another baking-powder plant, where he had learned the trade.

From the start, his chief concern had been to get the very best of raw materials, and to secure them from a source having the highest reputation for honesty and dependability. He had continued to buy all the ingredients of his baking powder from the same firm with which he had started at the beginning of his business.

Suddenly, out of clear skies, his goods began to come back to him from every direction—caked solid in the cans and containers! In his consternation he confessed that he had never employed a chemist and that he was a little inclined to be suspicious of them. But now he was “in the last ditch”; and he appealed to this science to pull him out. So far as he knew, his materials and his processes were identical with those he had used for years, which had given his baking powder a really enviable reputation in the trade. Yet express wagons and drays were bringing back to him hundreds of cans of the stuff, caked solid.

The chemist made an immediate survey of the plant and satisfied himself that the owner had stated his case without reservation. In a surprisingly short time the trouble was located. The starch, which formed the body of the powder, contained a too high percentage of moisture, and this was what started the stuff upon its normal course of chemical action.

Just how this disastrous surplus of moisture had crept into the starch the manufacturer of that article was unable to explain; however, the havoc that had been wrought by this surplus humidity had the effect of making a new and steadfast convert to the ranks of students of applied chemistry.

Often the integrity of employees is put under laboratory test. In such cases, however, the chemist doing the work is generally unconscious of the moral problem involved in his investigation. Here is an occurrence that gives a graphic illustration of how this question of personal loyalty can be sent to a test tube for determination:

The principal reagent used in galvanizing iron is sulphuric acid. This powerful acid bites rust and every other impurity from the surface of the iron and leaves it chemically clean. Without this treatment, the thin coating of secondary metal—usually tin or zinc—will not stick

to the iron. A purchasing agent, representing a large galvanizing concern in the East, bought three carloads of sulphuric acid at what he believed to be a bargain price. He sent it to the works and was greatly astonished, a little later, to be summoned to headquarters because the acid would not act properly on the iron. The coating would not stick to the iron—and that was all there was to it!

The atmosphere of the conference was decidedly electric, and the superintendent told the purchasing agent to take the three carloads of worthless stuff and send them back to the firm from which they had been bought. Also, the superintendent intimated it would be difficult for anybody to put over so raw a deal as that on him.

Instantly the purchasing agent retorted that not a carboy of the acid should be touched until the stuff had been subjected to chemical analysis in a laboratory entirely independent of the plant. He took no pains to conceal his

conviction that the superintendent had been bribed by the makers of the acid which they had been using before. Apparently the superintendent held an equally unflattering conviction concerning the purchasing agent.

The general manager recognized that the best interests of the concern demanded that the suggestion of the purchasing agent should be followed, and the whole problem was submitted to an independent chemist for a careful test, which would vindicate one or both of his immediate subordinates.

Almost immediately the consulting chemist found that the sulphuric acid contained a high percentage of arsenic, which had settled in a thin film upon the iron and had prevented the secondary or "coat" metal from sticking. The presence of the arsenic had not been discovered because it was almost the same color as the iron. The findings of the laboratory were highly satisfactory in the respect that they cleared the skirts

of both the purchasing agent and the superintendent of any suspicion of having been "reached" by firms selling sulphuric acid. On the other hand, this delay had held up production and put the factory in an uncomfortable position as to its deliveries. The outcome of the experience was that the purchasing agent added a new term to his specifications regarding sulphuric acid, this amendment reading: "Free from arsenic."

Why the Batteries Came Back

ONE of the most startling of all experiences due to the presence of an unsuspected element in a raw material fell to the lot of a large manufacturer of battery cells of the small type used in flashlights. This American manufacturer secured a single European order for more than a million of these cells. In the manufacture of dry batteries manganese peroxide ore is a standard material. Practically the entire supply of this ore, so far as American manufacturers

were concerned, came from the mines of the Caucasus Mountains, in Russia, up to the time when the great European war began. This calamity, of course, instantly stopped the influx of this ore and compelled the United States to look elsewhere for its supply of this material.

Beyond the fact that this Russian ore contained eighty per cent or more of manganese and only one per cent less of iron, the battery makers in America knew little of its characteristics or of why it suited the purpose of use in battery cells so perfectly. So long as it gave them no trouble whatever and they could get an unlimited supply of it, they were content to let their knowledge of manganese ore remain at a minimum.

When the Russian supply of manganese ore was shut off this particular manufacturer of battery cells began to look about in the market; and finally he found an ore from South America that seemed to fill his requirement of a content of eighty per cent or more of manganese and one per cent or less of iron.

Of course no manufacturer would be foolish enough to ship a million units of his product across the ocean without first subjecting them to a thorough test—especially when drawing his main raw materials from a new source. The batteries made of this new South American manganese worked perfectly in the factory test, and were sent to the other side without a question as to the satisfaction they would give.

When the manufacturer received a cable from his big European customer saying that the battery cells would not work, that they were all rejected and were being sent back at the shipper's expense, the entire factory organization felt the worst jolt it had ever received.

There was nothing to do but await the arrival of the returned goods.

Meantime samples of the ore were sent to a metallurgical chemist of the highest standing and were subjected to analysis. He told the manufacturer that, though he believed he had discovered the secret of

the trouble, he would suspend judgment until the arrival of the batteries themselves.

“I have found,” he explained, “a very small percentage of copper in the ore analyzed; but it is so minute—ten to fifteen one-hundredths of one per cent—it seems almost incredible that this should have caused the mischief.

An examination of the battery cells, however, showed conclusively that this chemist had hit upon the reason why the batteries would not work. Though present in an almost infinitesimal amount, there had been just enough copper to form a delicate film over the zinc, causing increased resistance, so that the full volume of electricity was not properly delivered.

No American manufacturer who has a million batteries thrown back on his hands by a European customer is going to continue to “go it blind” any longer so far as a thorough scientific examination of all his raw materials is concerned.

One lesson of that kind is ample. This concern is now going ahead on the basis that the time to lock the barn door is before the horse is stolen. In other words, it is making a consistent effort to use industrial chemistry to prevent losses instead of to explain them.

In this time of sensational prices competition in buying has reached the acute stage in almost every line of manufacture. This is especially true in the field of metals; and when a supply of material of this kind is offered on the market, at a price that gives it a distinct advantage, it inevitably becomes an object of suspicion. At least, where the amount of the purchase is likely to be large, the value of the material must be vindicated by a laboratory test. Chemists and laboratories, like courts and lawyers, thrive on suspicion. Though there would still be a certain demand for their services if all men were intentionally honest, their volume would be immensely reduced by a realization of ideal business morality.

As this millennial condition appears to be decidedly remote, the consulting industrial chemist finds that a large number of his clients are forced to seek his advice because of a suspicion that the goods offered are not exactly as represented.

Not long ago a large manufacturing concern, using an immense amount of babbitt for the bearings of shaft journals—to the end of reducing wear and friction—sent a sample of the metal to a consulting chemist, along with the specifications that this composition was supposed to satisfy. Later other samples were submitted. The letter of transmission intimated that the price at which this particular metal was offered was so much lower than that of all others coming in competition with it that it would be well to make the test so searching that the determination should be beyond doubt.

The Secret of the Cheap Babbitt

THESE instructions were carried out to the letter, and the chemist reported that the metal analyzed complied fully with the specifications. Not only this, but it was found to compare favorably with the competing samples submitted for analysis.

In spite of this showing, the purchasing agent was loath to change his source of supply without giving the concern from which he had long bought his bearing metal an opportunity to meet the competitive price.

"I can demonstrate to you," declared the maker of the bearing metal from whom the purchasing agent had been in the habit of buying, "that the raw materials going into the composition cannot be bought on the market to-day at the price at which this competitor offers you his finished product. You say that you can buy this stuff ten cents a pound less than my price. I should lose a lot of money at that figure, and you can bet

your last dollar there is a nigger in the woodpile somewhere."

The purchasing agent had the uncomfortable conviction that the metal dealer believed him guilty of playing a cheap and almost childish trick in an attempt to beat down the price of babbitt. So the buyer backed his statement by submitting the text of the low bid to the doubting and disappointed dealer. Then he called in the author of the bid and said substantially this:

"I'll admit that your price is a whole lot lower than that of any other competitor, and that your sample conforms entirely to our specifications; but before I place this order with you, it is up to you to give me a convincing explanation of how you happen to be able to undersell your competitor to such a radical extent."

"That's easy," came the quick answer. "I happen to employ a very keen chemist, who showed me how to beat the market on babbitt and still conform

strictly to quality and specifications. Not long ago I had an opportunity to buy a big quantity of scrap tin at what seemed to me to be a very favorable price. Of course I was not going to take any chances on putting tin into my babbitt that might not turn out right; so I took a sample of the stuff to a consulting chemist and explained in detail the use for which it was intended. When he made his verbal report on the analysis of the stuff he wore a broad smile.

Some Prize Problems

“**H** E ASKED me whether I had not been able to buy this tin at a price which was lower than the virgin metal because it contained alloy. He had guessed the situation precisely. Then he told me that in this case the alloy happened to be antimony; and, therefore, I was getting quite an amount of antimony at a price very much below what I should have to pay for the pure, virgin metal. Your bearing metal is

made of tin, antimony and copper—and consequently the copper and part of the antimony that go into your mixture are the only materials which cost me a normal market price. This is how I can undersell my competitors ten cents a pound and still make a very little more profit than they would make at their bids. And this isn't the first time, either, that a chemist has shown me the way to cut the corners in this business!"

No reader should entertain the notion that industrial chemistry is mainly concerned with the process of testing materials. Though it is true this is one of its standard and routine tasks, the fact remains that its big prizes, to which perhaps its most brilliant achievements are given, are in the realm of definitely constructive work. Chemists freely admit that in this field some of the most remarkable achievements are apparently the fruits of chance and accident, rather than of reason and far-sightedness.

This element of chance, in combination

with the alluring size of the prizes and the opportunity to make intelligence and shrewdness count, gives to industrial chemistry all the thrill and fascination of the turf or the gaming table.

Certainly it does not lack excitement—especially for those who are both experienced and ambitious.

The head of a celebrated laboratory in the East tells this story:

“In chemistry, as in everything else, we need the stimulus of a specific prize to draw out the best constructive work that is in us. The rawest laboratory recruit can make out a list of big industrial problems that need to be solved and that would bring wealth along with their solution; but it takes a man of uncommon temperament to go out after one of these general prizes with anything approaching the enthusiasm and application that he gives to the problem which has been brought to him personally.

“Well, our laboratory was just about cleaned out of what I should call prize

cases when I was called into consultation with the active manufacturing head of a large tobacco company. He explained that he had started to put a new brand of cigarette on the market, and he wished to give it what tobacconists would call a rich 'pound cake.' This particular flavor, he explained, was characteristic of the best pipe tobacco, chewing tobacco and cigars sent out from his factory. But all the efforts of his most expert blenders to get this peculiar quality in cigarette tobacco had been unavailing. He wished to retain me to attack this problem; and he named a large sum that would be paid as a bonus, in addition to the usual fee, if I could produce a cigarette tobacco that would have the true pound-cake flavor.

"Here was something worth while going after; I recognized at once that there was a big element of chance in the pursuit of this prize; but this fact only increased the fascination of the chase. The tobacco manufacturer gave me a box of

cigarettes made by another company that came fairly close to the ideal flavor he had in mind.

“Analysis and the microscope quickly disclosed the ingredients of this mixture. They were duplicated and combined over and over again, but the flavor did not approach that of the sample. Patience is one of the prime requisites in a chemical laboratory, and consequently, as a matter of course, we kept plugging away at this problem with unslacking persistence. One day, when we were apparently no nearer the solution of the problem than when we started, one of my assistants put some of the tobacco into a drying bath, and then became so absorbed in something else that he forgot all about it. When he discovered what he had done he was rather crestfallen, for a chemist is not supposed to let anything spoil for lack of attention. He fully expected to find this particular batch of tobacco completely spoiled; but when he tested it he gave an exclamation that

brought everybody in the room to attention. His accident had produced the precise pound-cake flavor for which we had been striving! It had a rich, distinctive flavor, and was of a quality to make a sure appeal to the average cigarette smoker.

“I took the ingredients, dried them separately, and made the vital discovery that licorice was used after it had been made hot. This was the secret of the rich flavor.”

Once commercial chemists were largely engaged in making mysterious mixtures, in concocting secret compounds from simple and inexpensive materials, which could be sold under impressive names at a huge profit. Many of them had merit and served the purpose they were supposed to serve; but their exorbitant margin of profit was based upon their mystery rather than their merit. To-day the tide has turned and chemists are kept busy taking these compounds apart to see what makes them go, and

incidentally to take the water out of their prices. Here is a case that clearly illustrates this class of laboratory experiences:

Seaweed in the Brewery

A BIG Western brewer sent a quantity of jelly-like substance to a consulting chemist in New York and made this comment:

“This jell is the only stuff I have been able to find that keeps my boilers free from the crust which forms from the water we are obliged to use; but the price the makers compel us to pay is becoming almost prohibitive. We use an immense quantity and the bill for this cleaner runs into big figures. The manufacturer claims, of course, that it is a secret compound and is costly to make. Somehow I suspect this isn't so, and that a substitute can be made at a much lower cost which will do the work just as well. See if you can discover what this stuff is made of and how to beat its price with-

out sacrificing any of its working value."

Soon the chemist reported that the compound was made almost wholly of a certain seaweed, very common on the Atlantic Coast, and that the cost of this weed was only a few dollars a ton. A large quantity of this seaweed was then secured and elaborate tests were made. It was discovered that it was not necessary even to cook the weed into jelly, but simply to put a certain quantity of it into the water of the boilers and when sufficiently cooked it would form the jelly which prevented the incrustation.

The thrifty brewer at once made a contract with members of the Atlantic Coast Life-Saving Service to gather this weed after it had been thrown up on the shore by a storm, bale it and ship it to him by the carload. As the life-savers did this in their leisure time it was very inexpensive. The change from the barreled mystery to baled seaweed was decidedly economical.

Another interesting phase of the in-

dustrial chemist's work as an unraveler of mysteries is in supplying missing links and restoring fragments of lost information. Secret processes and formulas are the every-day problems in this field of research. When the combination of furniture manufacturers took place it was found that the most successful polishing material was made by an old employee of one of the constituent companies. He realized that his opportunity had arrived and told the management of the consolidation that the mixing of the compound was his own secret, and would remain so until he was dead; that it had always been made in secret by his own hands and that he would divulge the process to no human being.

On the other hand, a much greater quantity of the mixture was necessary to supply all the factories. It was agreed that the old man should receive a greatly increased compensation, but that he must write out his formula in full and deposit it, under seal, in escrow, with a

trust company—to be delivered to his employers after his death.

In the course of a few years the old man died and an official of the company appeared at the laboratory of a consulting chemist, laboring under great mental excitement.

“Not even the old man’s assistant can make this formula work! I always thought old Fritz was the soul of honor and loyalty; but——”

“Perhaps,” interrupted the chemist, “it might be well to await developments before questioning that conclusion.”

When the chemist came to mix the preparation he discovered that a single element, which was so obviously necessary as to be almost self-evident, had been omitted from the old man’s formula. Clearly it had not been left out by intention, but rather because the old man had taken its use for granted. The discovery of this was the one vital thing that prevented the formula from dying with him.

Boiled in the Wrong Kettle

OCCASIONALLY the researches of the industrial chemist bring strange commercial secrets to the surface. These are sometimes as contradictory as they are curious. A celebrated New York chemist tells this odd story:

“One of the fascinating features of this profession is that its Pandora Box of surprises is never exhausted. Perhaps the oddest development that an analysis in my laboratory ever brought to light was the finale of a case brought in by a large dealer in molasses. This distressed food jobber had sent a large shipment of Barbados molasses to Newfoundland, where this sweet liquid is largely used as a substitute for sugar and is a big staple of the regular diet of the fisherfolk. All my troubled client told me was that this big shipment was on the point of being sent back to him, on the ground that it was not Barbados molasses, and the consumers would not stand for it; and that he had submitted it to leading members of

the trade in the United States, who pronounced it a very superior molasses.

“As the sum the jobber was likely to lose was a large one, I went into the matter quite thoroughly and made determinations of almost every make of molasses of which a sample was obtainable.

“My analysis of the rejected molasses showed that it contained a slight trace of iron, while the analysis of a sample obtained direct from Barbados did not reveal a trace of this element. Here was a lead that was instantly followed. Investigation disclosed the fact that at that time only copper kettles were used in refining in Barbados, while iron kettles were in common use by the producers of New Orleans molasses.

“Naturally the next question to be raised was why the presence of a slight trace of iron in molasses should render that sweet especially unacceptable to the people of Newfoundland. Instantly the fact that you cannot bring iron into contact with tea without producing a salt of



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tannic acid came to my mind. The Newfoundlanders are inveterate tea drinkers; and an inquiry revealed the fact—which my client had neglected to mention—that sweetening tea with molasses is a common practice among the people of the Newfoundland coast.

“Here, to my sense, was the explanation of the whole trouble. I told the jobber he would undoubtedly find that his

unfortunate shipment was New Orleans molasses and had never seen Barbados. He responded that if the New Orleans article was cheaper, instead of higher, he could understand how and why this might be true.

“When he went to the dealer from whom he had bought the stuff, that crest-fallen merchant made the amazing confession that he had substituted the more expensive New Orleans molasses because he wished to make so favorable an impression upon this big jobber that he would become a permanent customer. And his stroke of enterprise might have been a marked success had it not been for the trace of iron in the New Orleans product and the fact that Newfoundlanders use molasses in their tea. Of course the overzealous dealer made good the jobber’s loss.”

Let no manufacturer imagine that, to put an end to his production troubles, he has only to hire a chemist or install a laboratory. Even by its most ardent advo-

cates, chemistry is not offered to industry as a cure-all for its entire line of complaints. It will not act as an automatic substitute for common sense; nor will it take the place of sound business management. It seems altogether likely that a large majority of the laboratories installed in manufacturing plants in this country have been distinct disappointments to their sponsors and builders.

Probably no other American has done more than the late Prof. Robert Kennedy Duncan to induce chemistry and industry to come under the same yoke and pull together; yet this pioneer in co-ordinating commerce and science made this startling statement:

“Personal observation, however, for several years leads me to state that presumably ninety-five per cent of so-called factory research is worse than loss—worse than loss because the failure of the individual instance places a finale on the possibility of that particular factory to understand the advantage of applied sci-

ence. The normal failure that attends factory research is due to ignorance of the canons of judgment in choosing chemists, inexperience in dealing with them, and a general lack of knowledge of the facilities with which it is necessary to furnish them—laboratory, library and living facilities. I have met tragic instances of chemists possessed of high training, creative power and practical character, working under the most shameful conditions, burdened with routine drudgery, subjected to the interference, and orders even, of factory foremen; and—what is even worse—working under an entire misapprehension and ignorance on the part of the officials of the company as to their possibilities and value. I have seen them working under every circumstance of discouragement, inadequate facilities and bad treatment.”

This authority as frankly admits that he has found corporations giving good opportunities to chemists wholly inadequate and unqualified for their tasks.

There are two types of distinctly industrial laboratories: That which is operated on a straight commercial basis, and that maintained by a manufacturing concern for its exclusive use. In the class first named are several very large and admirably equipped institutions of national reputation. Though they are operated for profit, they are semipublic in many of their characteristics. Next in this class come the consulting chemists, of all kinds and ranks, some of them maintaining laboratories larger than those of many a state university. To these must turn not only the small manufacturer, with his pressing problems, but also the large manufacturer who wishes to check results reported by his own chemists, or who must have materials passed upon by an outside and impartial authority, whose decision will not be questioned.

Any small manufacturer who feels himself moved to reach out, for the first time, for the aid of industrial chemistry,

may justify his venture with two comforting considerations: That the fruits of this science are generally cheap compared with those of expert legal or surgical talent, and that the chemist's brand of professional honor and secrecy is quite as high as that maintained in either of those respected and familiar professions.



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